

LA-UR- 04031  
11-0531

Approved for public release;  
distribution is unlimited.

*Title:* Recent Onsite Gamma Measurements at the Trinity Test Site and a Comparison to Trinitite Samples

*Author(s):* Philip Hypes, N-4  
David Mercer, IAT-3  
Paul Saey, International Atomic Energy Agency

*Intended for:* INMM 52nd Annual Meeting  
Palm Desert, California USA  
17-21 July 2011



Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

## **RECENT ON-SITE GAMMA MEASUREMENTS AT THE TRINITY TEST SITE AND A COMPARISON TO TRINITITE SAMPLES**

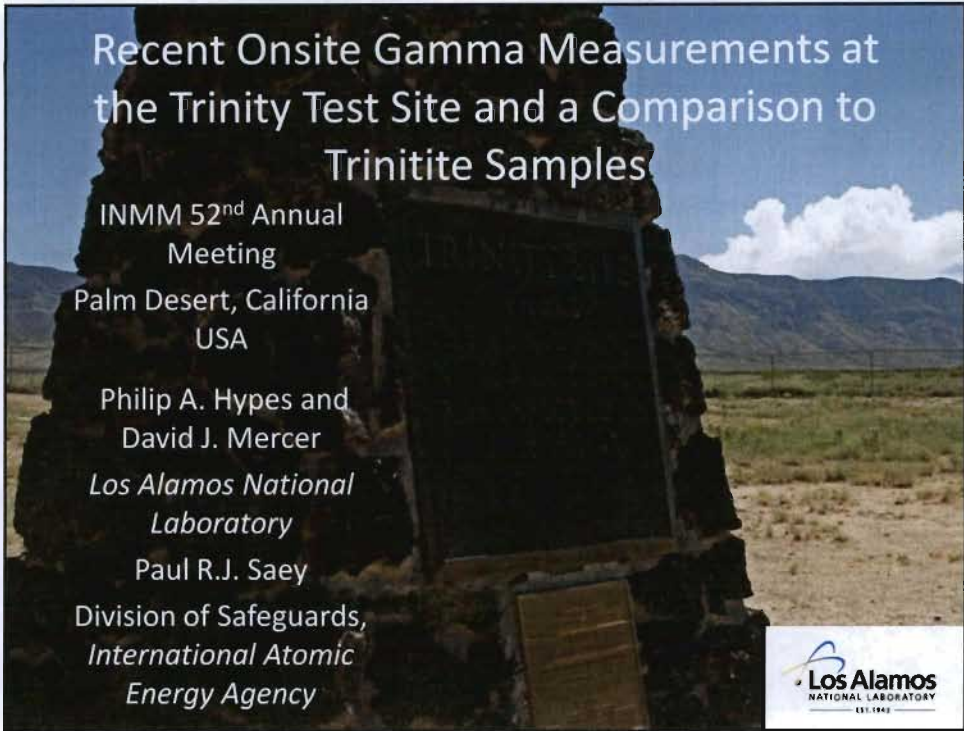
David J. Mercer and Philip A. Hypes  
Los Alamos National Laboratory, Los Alamos, NM, U.S.A. 87545

Paul R.J. Saey  
Division of Safeguards, International Atomic Energy Agency  
Wagramer Strasse 5, P.O. Box 100, 1400 Vienna, Austria

### **ABSTRACT**

The world's first nuclear device was detonated on 16 July 1945 near Alamogordo, New Mexico. The device, called "The Gadget," was placed on a 100-foot-tall steel tower and detonated with a yield of about 20 kilotons. The desert soil was drawn into the fireball, was melted and mixed with radioactive debris, and then rained down to form a green glass that would be named "Trinitite." This material was heavily scavenged by mineral collectors, and in 1952 most of the remaining material in the crater was bulldozed and buried. Visible particles of Trinitite near ground zero are very sparse; however, the soil still retains some radioactivity.

During a recent visit to the site, we collected spectra at several locations near ground zero using a mechanically cooled high-resolution gamma spectroscopy system. We report results from these measurements, as well as laboratory measurements of Trinitite samples and glass samples obtained from nuclear detonation sites in Nevada and Semipalatinsk.



# Recent Onsite Gamma Measurements at the Trinity Test Site and a Comparison to Trinitite Samples

INMM 52<sup>nd</sup> Annual  
Meeting

Palm Desert, California  
USA

Philip A. Hypes and  
David J. Mercer

*Los Alamos National  
Laboratory*

Paul R.J. Saey

Division of Safeguards,  
*International Atomic  
Energy Agency*



## Background

- Thanks to the cooperation of the White Sands Missile Range Office of Public Relations, a Trinity Site tour was arranged for visiting IAEA inspectors in August 2010
- An IdentiFINDER and an Ortec microDetective were brought along to take measurements
- These measurements were compared to measurements of several samples of trinitite and similar samples from Nevada and Semipalatinsk test sites



## What is Trinitite?

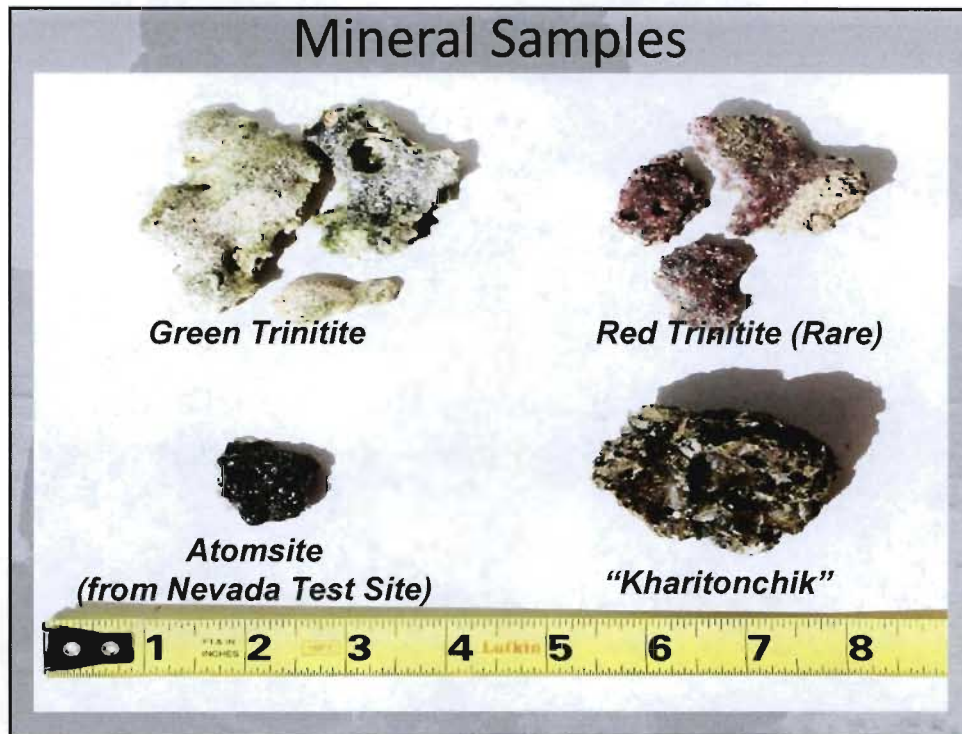
- Sand at the test site gets sucked into the mushroom cloud
- Heat melts the sand
- Molten sand traps radioactive material and rains out onto the ground



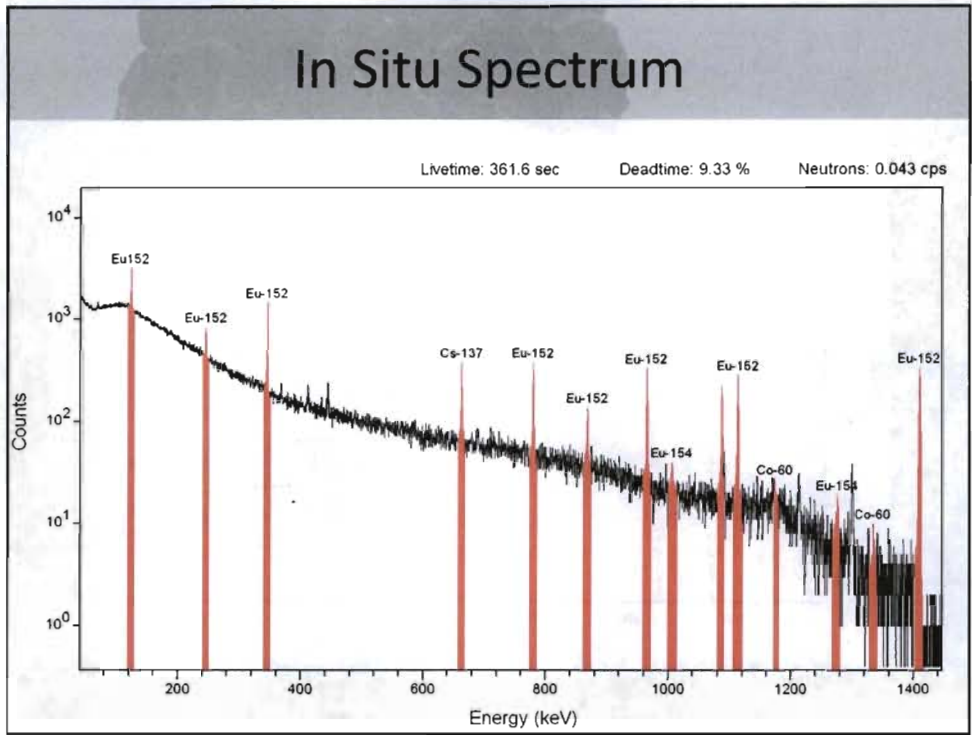
“After the Trinity detonation, a “sea of green glass” was left behind (video). This is the man-made mineral “Trinitite”.

Trinitite was probably formed by sand and soil that was drawn up into the fireball, melted, and rained down.

Radioactive fission products, nuclear fuel, and neutron activation products are still visible.”

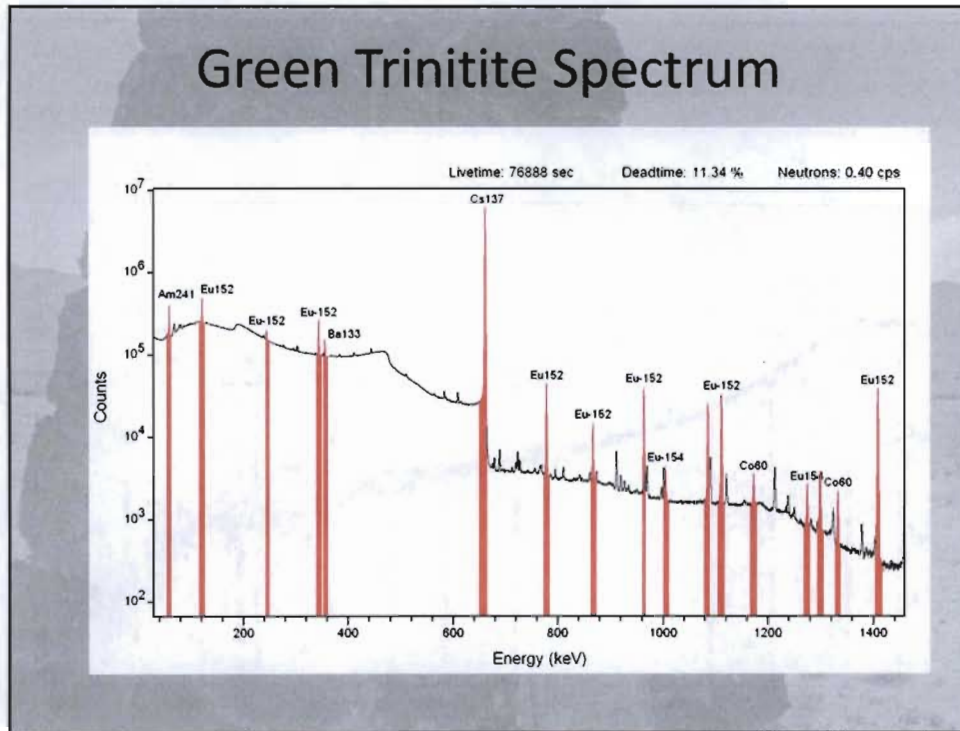


Green; normal WSMR trinitite Red; contains material from copper cabling Large black; Kharitonchik from the site of the first Soviet detonation (Joe 1 by western designation). The same location was also used for the Joe 4 (Lightning 6), the first Soviet thermonuclear test, so this sample probably witnessed both explosions. Small black; NTS material



Most radioactivity observed is due to Eu-152 and Eu-154 (irradiated soil). Some Cs-137 was visible (fission), and trace amounts of Co-60 (irradiated steel).

## Green Trinitite Spectrum

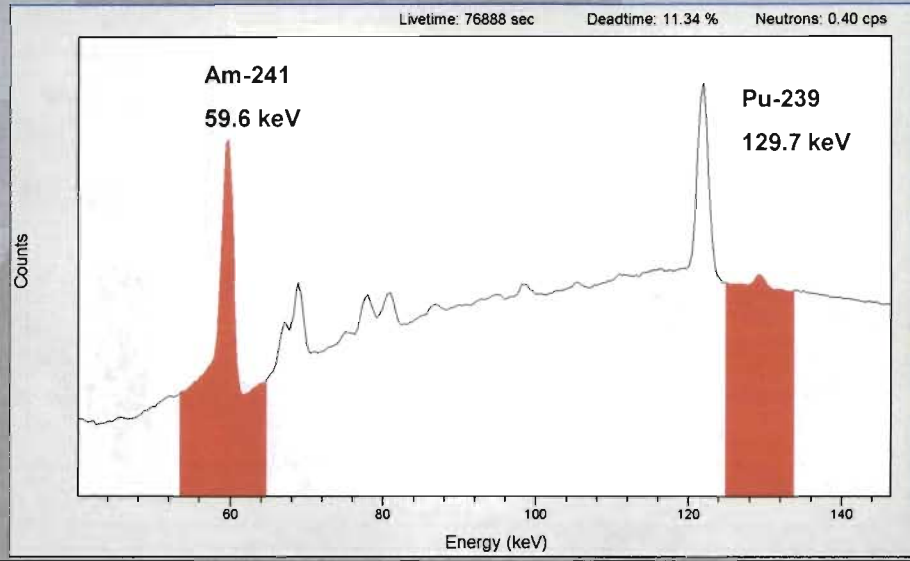


Green Trinitite; Am241 and Pu239 both directly visible

Cs-137 *dominates* the spectrum (especially compared to previous spectrum), with strong Eu-152 and Eu-154 and trace Am-241, Pu-239, and Ba-133.

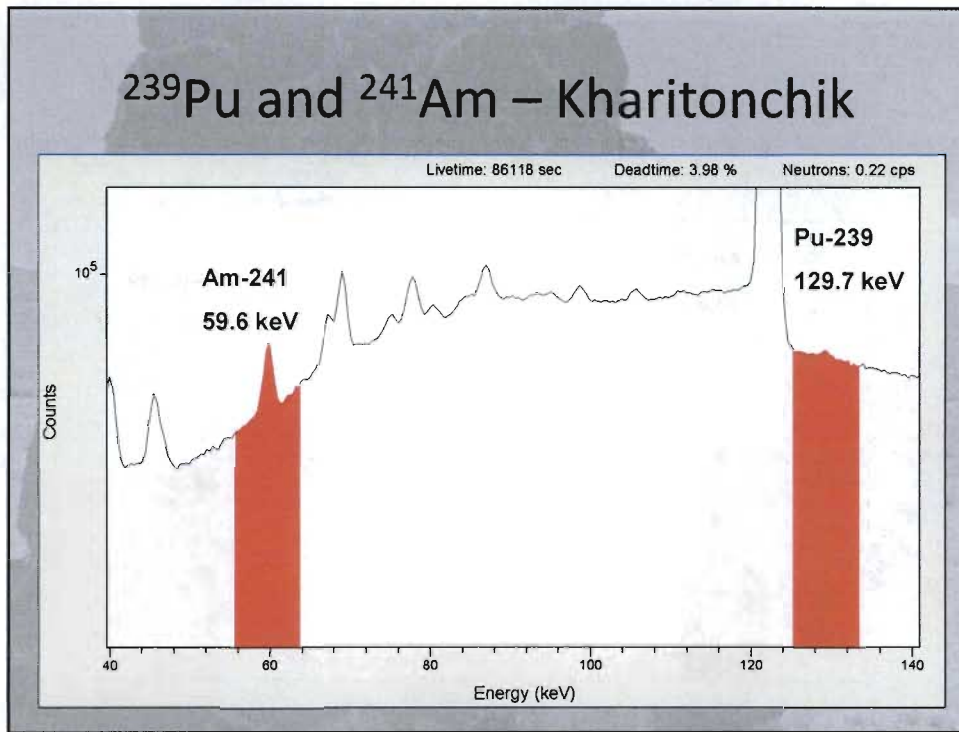


# $^{239}\text{Pu}$ and $^{241}\text{Am}$ in Multi-Kilogram Trinitite Sample



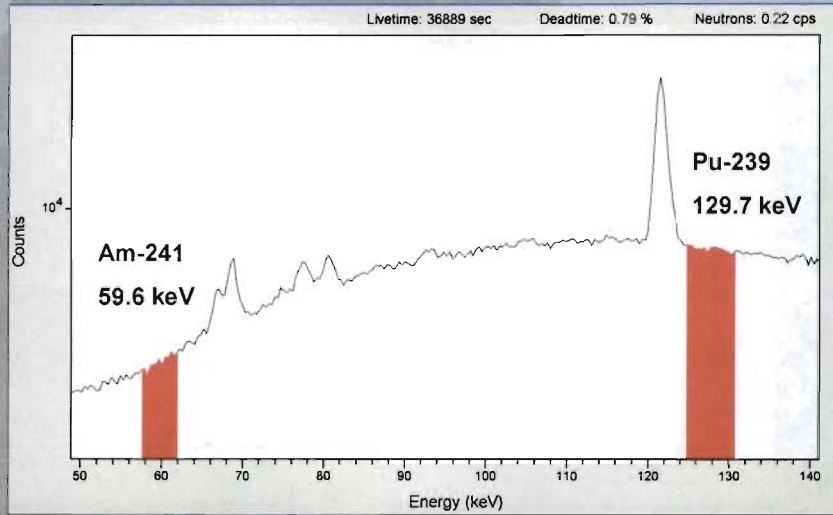
ACRS

## $^{239}\text{Pu}$ and $^{241}\text{Am}$ – Kharitonchik



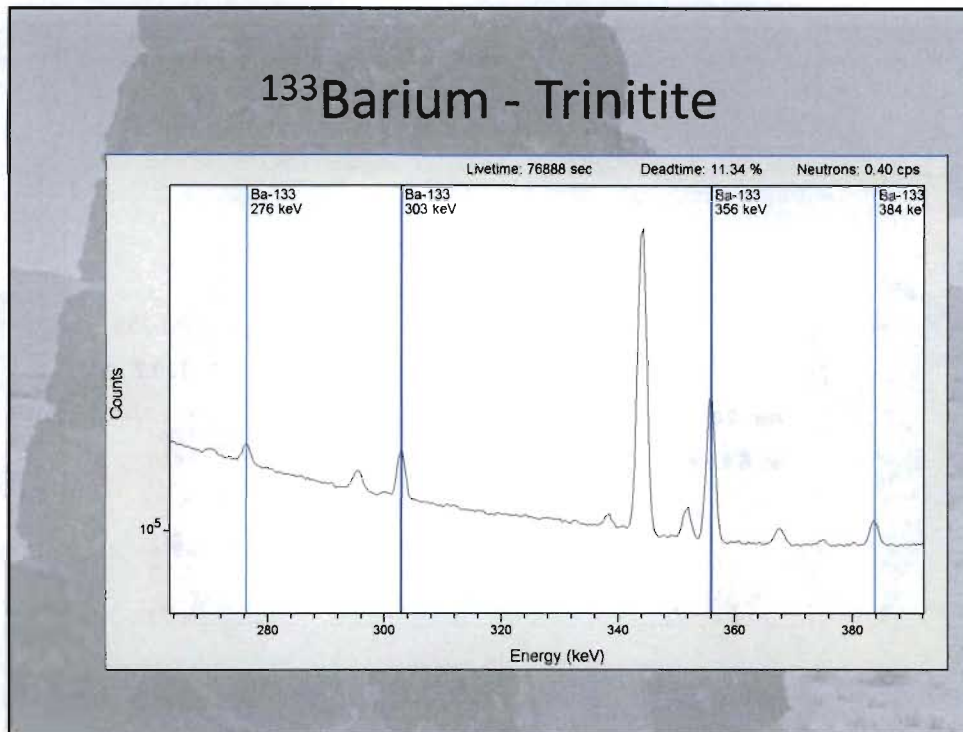
$^{241}\text{Am}$  clearly present.  $^{239}\text{Pu}$  peak is 6 sigma above background.

# NTS Material



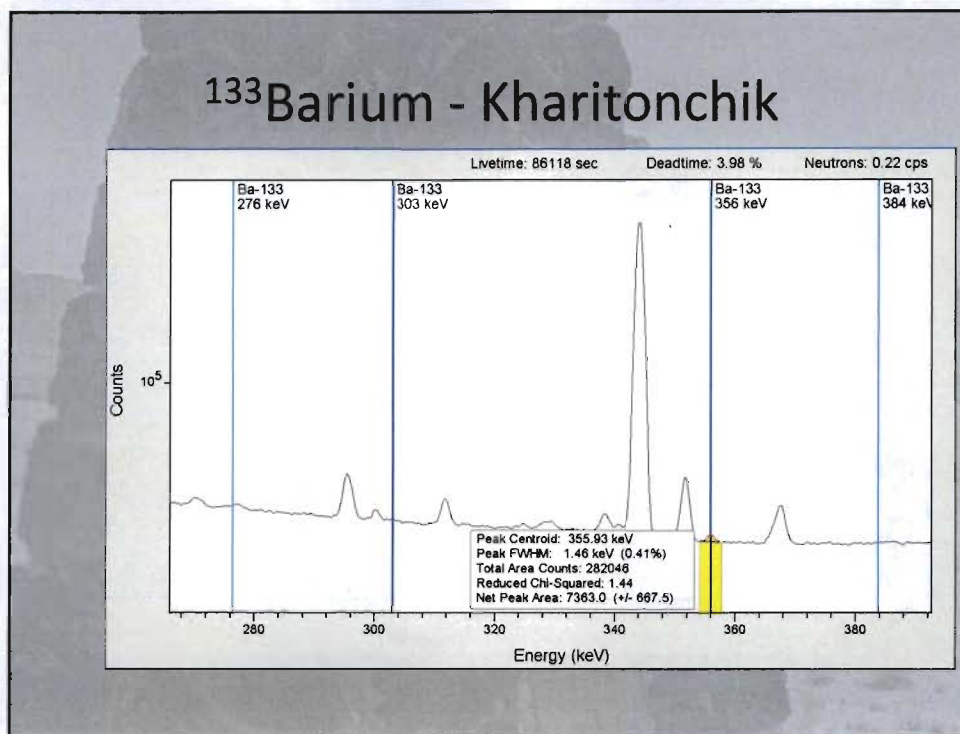
No evidence of Am/Pu; no Pu in the device.

# $^{133}\text{Ba}$ Barium - Trinitite



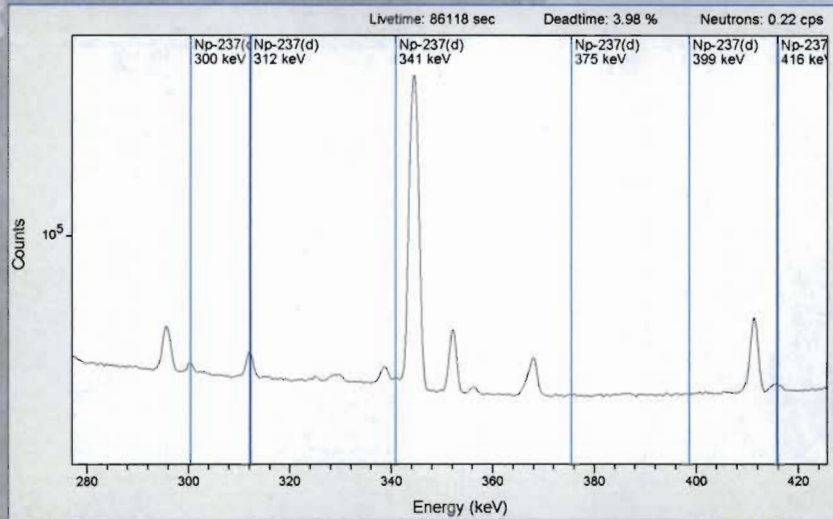
Barium is an activation product of weapon components. It can also come from activation of the soil, for both WSMR and NTS. This is the multi-kg trinitite spectrum.

# $^{133}\text{Ba}$ - Kharitonchik



Barium is an activation product of weapon components. As far as we know, this is the first reported observation of barium 133 in Kharitonchik. Not surprising if Joe 1 was similar to the Trinity test.

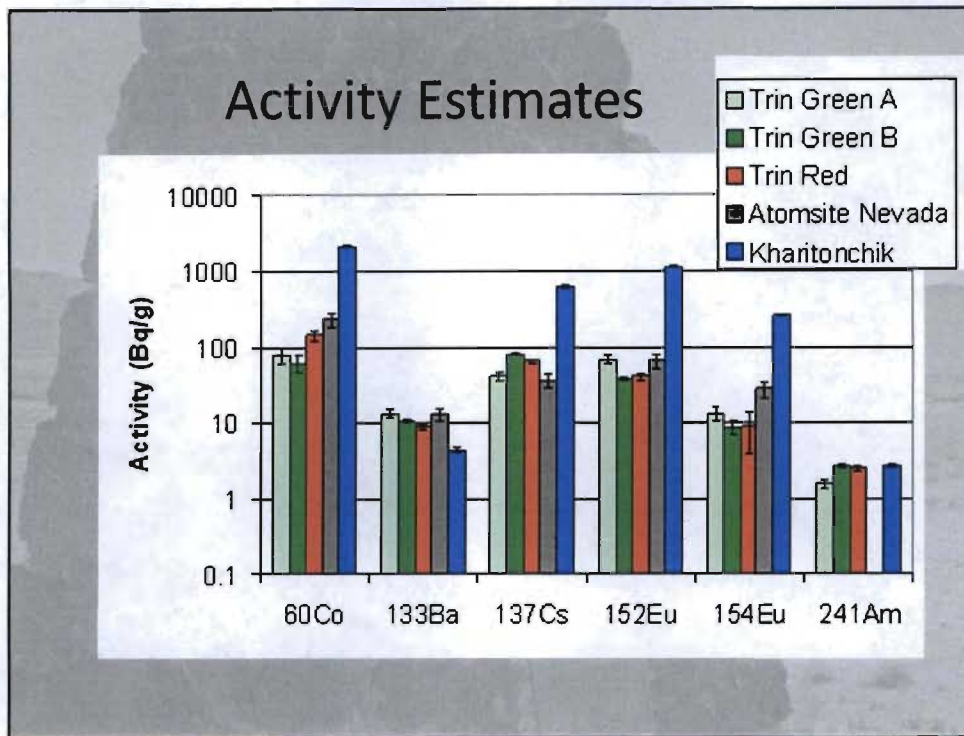
## $^{237}\text{Np}$ in Kharitonchik Spectra



n, 2n on U238, or multiple neutron capture on U235; most likely present because of the Joe-4 (Lightning 6)

*Verbal: This was a little surprising, and was not observed in Trinitite. The Np probably comes from neutron irradiation of uranium that was present in the Joe 4 device. It was a thermonuclear explosion so there were many more neutrons available.*

*It could be from  $\text{U}235+2n$  or from  $\text{U}238(n,2n)$ . Probably both contributed. I don't know which process is dominant.*



Forensic analysis of the Atomsite from Nevada indicates that there was no Pu in the device tested at that location. Decay corrected to the dates of the explosions. Red Trinitite does appear to have more metal in the source material, judging by the  $^{60}\text{Co}$  values

The Kharitonchik does appear to have Barium; this is the first reporting of that observation. The Kharitonchik is more active because of multiple shots at that site, which includes some fusion device residue.

The first observation is that K has much stronger Co, Cs, and Eu, although Am is about the same and Ba is lower. This is consistent with a much higher neutron flux and many more fissions than the Trinity explosion. We also saw Eu-155 in K, which is a pure fission product. Interestingly, there isn't more  $^{241}\text{Am}$  in the Kharitonchik.

As already mentioned, the Nevada sample shows no evidence for Am, so probably did not use Pu fuel.

The Nevada sample and the Red Trinitite are otherwise similar to Green Trin, but have 2-3 times more Co-60. Possibly they contain more steel residue.

Pu is not shown here because it was very weak and hard to quantify accurately.

## Compare to in Situ soil measurements

- We are not able to make an activity comparison to due to calibration issues. This might be a task for the next visit.
- In Situ soil contained no visible Am-241 or Pu-239, and about 30x less Cs-137 compared to Eu-152 and Eu-154.

Trinitite pieces were scavenged by collectors, and the surface was bulldozed in 1952 to remove the rest. What remains is neutron-irradiated subsoil (with activated Europium) and only trace amounts of Trinitite.



*Illegal scavenging of Trinitite, 1951*

Big difference between in situ and actual Trinitite; no fuel material in situ, and much less cesium in situ.